Cost-Effectiveness Model of COVID-19 Vaccination: The United Kingdom Perspective

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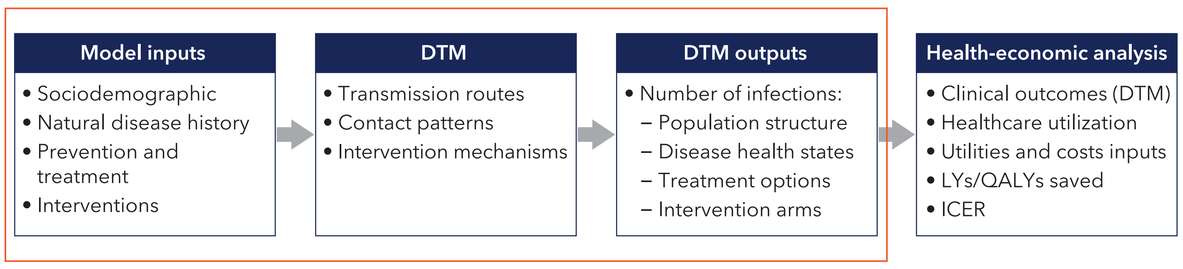
BACKGROUND

- Vaccination to prevent COVID-19 has been a vital tool in controlling the pandemic, mitigating the disease burden[1]
- However, the evolving nature of the disease calls for analyses of its trajectory and assessments of the cost-effectiveness of vaccination
- Since the majority of the population has received primary vaccination in many countries, it is important to evaluate different boosting strategies
- NVX-CoV2373, a recombinant spike protein vaccine with a saponin-based adjuvant (Novavax, Inc., MD, USA), has demonstrated efficacy in preventing COVID-19 in clinical trials[2-4]
- This study aimed to develop and validate the outputs of a dynamic transmission model (DTM) populated using recent data identified by a targeted literature review (TLR)
  - The model will be expanded with cost and health outcomes data to assess the cost-effectiveness of adding NVX-CoV2373 to the current UK vaccination programme

METHODS

- A new deterministic compartmental DTM was developed, partly based on previously published works[5,6], to simulate the transmission dynamics of COVID-19 (**Figure 1**)

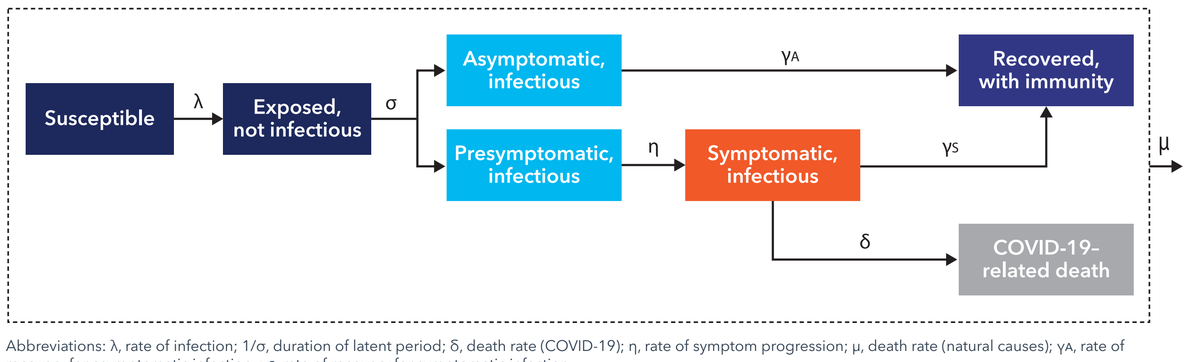
Figure 1. Model Components and Non-Exhaustive Lists of Outcomes



The red box represents the part of the model described in this poster; the health-economic analysis will be a later addition to the model.
Abbreviations: DTM, dynamic transmission model; ICER, incremental cost-effectiveness ratio; LY, life year; QALY, quality-adjusted life year.

- A TLR was conducted to inform the model design and to identify data on:
  - Efficacy and safety in previously vaccinated populations
  - Duration of vaccine protection
  - COVID-19 transmission patterns
  - Disease severity
  - Mortality rates
- The TLR included DTM studies and cost-effectiveness analyses of vaccination against COVID-19 or other respiratory viruses over a 10-year period (2013-2022)
  - No restriction was imposed on geographical location
  - Searches were performed in Embase and Medline
- The TLR resulted in more than 1000 hits during the initial screening of titles and abstracts, revealing a large number of DTM studies eligible for inclusion (acceptance rate ≈80%)
  - A pragmatic approach to screening was therefore adopted: the 100 most recent publications were reviewed for studies relevant to the UK specifically, which were then used to populate a previously developed data extraction template
  - Remaining data gaps were filled using ad hoc literature searches (eg, utilities), official statistics (eg, COVID-19 deaths) and standard reference sources (eg, unit costs)
- 29 studies were selected for further model design consideration and to provide parameter inputs
  - 8 were related to COVID-19 disease burden
  - 10 were cost-effectiveness analyses of COVID-19 vaccination strategies
  - 11 explored the dynamics of social mixing patterns
- The model separated the population into 6 compartments (**Figure 2**):
  - Susceptible
  - Exposed but not infectious
  - Asymptomatic infectious
  - Pre-symptomatic infectious
  - Symptomatic infectious
  - Recovered with immunity to infection

Figure 2. Description of Disease Dynamics in the Model



Abbreviations: λ, rate of infection; 1/σ, duration of latent period; δ, death rate (COVID-19); η, rate of symptom progression; μ, death rate (natural causes); γA, rate of recovery for asymptomatic infection; γS, rate of recovery for symptomatic infection.

- The underlying population was separated into those who were vaccine-naïve and previously vaccinated against COVID-19 and was stratified based on age and pre-existing conditions
- The following parameters were used to specify the model (**Table 1**):
  - Disease dynamics (eg, susceptibility and infectiousness relating to exposure, symptomatic states, and immunity)
  - Force of infection (eg, based on prevalence of cases, an age-dependent contact matrix, and the rate of transmission; adjusted for infectious state and vaccination status)
- Vaccine efficacy was based on clinical trial data for NVX-CoV2373[2,14]
- Outputs included the number of asymptomatic and symptomatic COVID-19 cases and the number of vaccines administered, which were used as parameter inputs in a separate cost-effectiveness module (which will be developed later, in the next phase)
- The current DTM evaluates and compares the outcomes of two scenarios: 1) when the population is offered COVID-19 vaccination and 2) when no vaccination is provided
  - In the future, we will be looking at different vaccine combinations, with and without NVX-CoV2373
- As per recommendations from the Joint Committee on Vaccination and Immunisation[15], vaccination would be administered to all adults aged ≥50 years, persons aged 12-49 years in a clinical risk group, and health care workers
  - In the current model, all vaccinated persons are assumed to have received the NVX-CoV2373 vaccine
- The model evaluates COVID-19 infection risk and vaccination over a single year but follows the consequences of the events for the remaining lifetime of the population

Table 1. Model Inputs

Parameter	Value	Data source
Demographic parameters		
Population estimates	Age-based	OfNS 2021[7]
Population with preconditions	Age-based	Walker JL et al. 2021[8]
Contact parameters		
Age-based contact matrix	POLYMOD	Klepac P et al. 2020[9] Mossong J et al. 2008[10]
Disease dynamic parameters		
Duration of latent period	4 days	Davies NG et al. 2020[5]
Proportion of infections that are asymptomatic, by age group	Age group: 0-9: 0.33 10-19: 0.36 20-29: 0.30 30-49: 0.25 50-65: 0.21 65+: 0.12	Wang B et al. 2023[11]
Duration of asymptomatic infection	5 days	Davies NG et al. 2020[5]
Duration of pre-symptomatic stage	1.5 days	Davies NG et al. 2020[5]
Duration of symptomatic infection	3.5 days	Davies NG et al. 2020[5]
Duration of natural immunity	45 weeks	Sandmann FG et al. 2021[6]
COVID-19 related death rate	Age-based	OfNS 2023[12]
Vaccine parameters		
Vaccination rate	Age-based	The National Archives 2022[13]
Duration of vaccination-induced immunity	3 months maximum efficacy, followed by 8 months exponential decline	Heath PT et al. 2023[2] Áñez G et al. 2022[3] Heath PT et al. 2021[14]

Abbreviations: OfNS, Office for National Statistics.

RESULTS

- The model predicted that 23.6 million vaccine doses would be administered; 11,765,791 in those with preconditions and 11,867,527 in those without preconditions
- The number of predicted symptomatic cases (laboratory confirmed) was 4.66 million in the scenario where vaccination was offered and 6.29 million if no vaccination was offered (**Figure 3**)
  - Validation of model outputs shows that the predictions were close to the actual number of cases reported in the year 2022
- Additional model outputs (**Table 2**) show that about 1.62 million symptomatic COVID-19 cases and approximately 370,000 cases of long COVID-19 could be avoided

Figure 3. Number of Predicted Symptomatic vs Actual Data for 2022

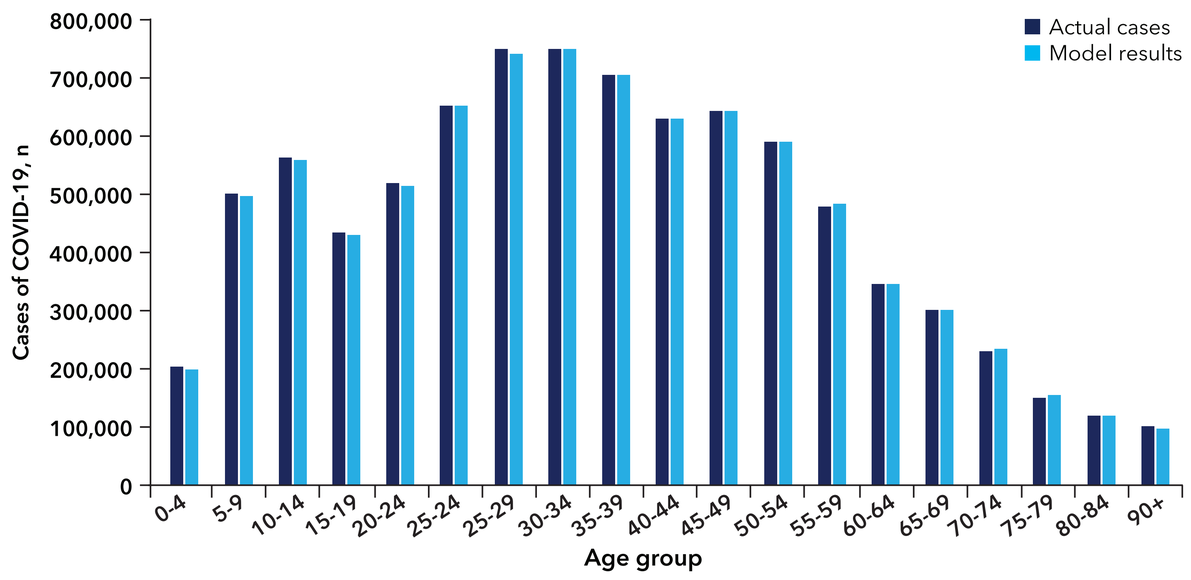


Table 2. Model Outputs

	Cases averted from vaccination	
	In those with preconditions	In those without preconditions
Symptomatic COVID-19 cases	1,052,620	578,367
Cases of long COVID-19	224,169	142,080

CONCLUSIONS

- This study provides an up-to-date disease model to evaluate the impact of vaccination against COVID-19 and will be used to assess the cost-effectiveness of adding NVX-CoV2373 to the UK vaccination programme
- Modelling suggests that a scenario where NVX-CoV2373 vaccination is offered in the UK for a single year has the potential to reduce the number of symptomatic COVID-19 cases by 1.62 million and the number of long COVID-19 cases by 366,000
- This analysis is important for policymakers, health care providers, and other stakeholders to understand the cost-effectiveness of NVX-CoV2373, inform future vaccination strategies against COVID-19, and reduce the health care burden associated with COVID-19

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Disclosures/Conflicts of Interest:
MZG, RP, CP and KZHL are employees of ICON Clinical Research. JL and LK are employees of Novavax Europe and may hold stock options. MS is a paid consultant for Novavax. DMS has undertaken consultancies for GSK, Sanofi, Cansino, Clover, Pfizer and Novavax. CC has received payments and grants to her institution from GSK, Moderna and Novavax for studies and work performed. She has not received any personal financial rewards.